

Traumatic Brain Injury Annual Surveillance Report 2016 Data

Division of Family Health and Wellness



A Note to the Reader

Readers should interpret all findings with caution. In some cases, and particularly when examining county-level data, the counts provided in this report are small (≤ 20) and therefore, rates and other calculations may be statistically unreliable.

We encourage caution in interpreting results and comparing differences across counties. If you have questions about particular data points or need assistance interpreting the data, please contact:

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Executive Summary

In 1993, the Tennessee General Assembly established the Tennessee Traumatic Brain Injury Program and Registry to address the growing needs of brain injury survivors within the state. Tennessee Code Annotated 68-55-203 mandates that the Department of Health develop and maintain a registry of these survivors. Data collection began in 1996, ultimately producing an annual report summarizing the prevalence of traumatic brain injury, or TBI, across the state. Since inception, the Registry has collected data on over 150,000 patients and has connected Tennessee TBI survivors with vital resources for their recovery. Data from the Registry has also been advantageous in detecting populations at risk for and prevalent mechanisms of TBI in order to enhance and tailor prevention efforts. The findings in this report serve to continue and enhance these efforts.

Key Findings

- A total of 11,334 unique patients were reported to the TBI Registry during the 2016 calendar year. Of these, 7,471 presented with a TBI-related hospitalization (length of stay \geq 24 hours) and 843 were deceased.
- 54% of all TBIs were in the senior population (over 55 years).
- Overall, 58% of TBI patients were males. The number of male TBI patients exceeded females in each age group except in patients over 75 years.
- Falls were the leading cause of TBI in Tennessee, followed by motor vehicle accidents.
- Over 10% of concussion-related hospitalizations in 2016 were sports-related, but overall, sports-related concussions are likely underestimated.
- The age-adjusted TBI hospitalization rate for Tennesseans in 2016 was 84.17 per 100,000, while the age-adjusted death rate was 9.11 per 100,000 residents.

Traumatic Brain Injury in Tennessee

Introduction

Traumatic brain injuries (TBIs) are acquired injuries, caused by a “bump, blow, or jolt to the head, or a penetrating head injury that disrupts the normal function of the brain¹”. Because of their nature, TBIs are a major cause of death and disability, making these injuries a significant public health problem across the United States. In order to address the unique needs of Tennesseans who have sustained a TBI, the Tennessee General Assembly established the Tennessee Traumatic Brain Injury Program and Registry in 1993.

The Tennessee Traumatic Brain Injury Registry began collecting brain injury data in 1996 with the core purpose of connecting TBI survivors, via a survivor letter, with resources available to them during the course of their recovery. All non-federal reporting hospitals (n=130) are mandated to submit any traumatic brain injury-related hospitalization (patients with a length of stay of at least 24 hours) or death (patients who expire at or before reaching the facility) to the Registry.

All patients meeting these criteria are to be reported to the Registry, regardless of residence, although only Tennessee residents actually admitted to the hospital receive survivor letters from the Program. Required data fields include various demographic, injury, and facility information. Patient inclusion for the annual report is determined by date of discharge. Short-stay ED or less than 24 hour TBI-related emergency department visits are increasingly submitted, but are not compulsory.

The data within this report describe the causes of TBIs in Tennessee and support the planning and implementation of initiatives to reduce these injuries throughout the state. Information presented in this surveillance summary is based on final data collected by the Tennessee TBI Registry for the calendar year of 2016.

¹ Basic Information about Traumatic Brain Injury and Concussion. (2016, January 22) Retrieved from: <http://www.cdc.gov/traumaticbraininjury/basics.html>

Note on Coding Terminology

Data submission in International Classification of Diseases Tenth Revision, Clinical Module (ICD-10-CM) format began on October 1, 2015, making 2016 the first full year of data submission in this format. ICD-10-CM coding is intended to enhance the quality of healthcare data in the United States, in turn improving epidemiological research. In particular, ICD-10-CM codes provide significantly more detail on the clinical event. Brain injury codes benefit from the higher level of detail, especially in respect to severity and laterality. Table 1 provides the proposed ICD-10-CM surveillance definition for traumatic brain injury, as designated by the Centers for Disease Control and Prevention.

Table 1. ICD-10-CM Code Ranges for TBI Surveillance, CDC definition, 2016².

ICD-10-CM Code	Description
S02.0, S02.1-	Fracture of skull
S02.8, S02.91	Fracture of other specified skull and facial bones; Unspecified fracture of skull
S04.02, S04.03-, S04.04-	Injury of optic chiasm; injury of optic tract and pathways; injury of visual cortex
S06-	Intracranial injury
S07.1	Crushing injury of skull
T74.4	Shaken infant syndrome

"-" indicates any 4th, 5th or 6th character

7th character of A or B for S02.0, S02.1-, S02.8 and S02.91

7th character of A for S04.02, S04.03-, S04.04-, S06-, S07.1 and T74.4

It is important to note that these definitions only collect initial encounters (7th character of 'A' and/or 'B' depending on the ICD-10 code), allowing for a better estimation of prevalence. However, this makes any readmission analyses difficult. While outside of the scope of this report, an analysis of readmissions due to TBI would be helpful in estimating burden.

ICD-10-CM is new for collecting clinical morbidity-related data, therefore we do not yet have standards for measurement of sensitivity and specificity of these codes. Thus, this proposed definition may be altered as more data become available.

² Hedegaard, H; Taylor, C. A surveillance case definition for Traumatic Brain Injury using ICD-10-CM. National Association of State Head Injury Administrators. Webinar, September 17, 2015.

General

From January 1st to December 31st, 2016, there were 11,334 unique patient encounters reported to the Tennessee TBI Registry. A total of 10,013 patients were found to have appropriate TBI-related codes as outlined in Table 1. As stated in the Introduction, hospitals are only required to report TBI-related deaths and hospitalizations. Patients who are treated and released from the emergency department are not required to be reported to the Registry and are therefore excluded from the analysis. In 2016, 2,392 patients were classified as emergency visits and thus removed from the analysis, leaving a total of 7,621 patients who met the criteria for mandated report to the Registry. Of these 7,621 patients, 6,778 were hospitalized and discharged alive. The remaining 843 patients died as a result of their injuries.

*On average, around
8,000 TBI-related
hospitalizations occur
in Tennessee annually.*

Of the 7,621 patients required to be reported to the Registry, 89% (N=6,778) were alive at discharge (Table 2). 48% (N=3,691) of patients were released with self-care instructions, indicating a modest level of independence and less disability. Still, 38% (N=2,862) required further, potentially more extensive treatment post-hospitalization.

Table 2. Reported discharge status of 7,621 TBI patients, Tennessee 2016.

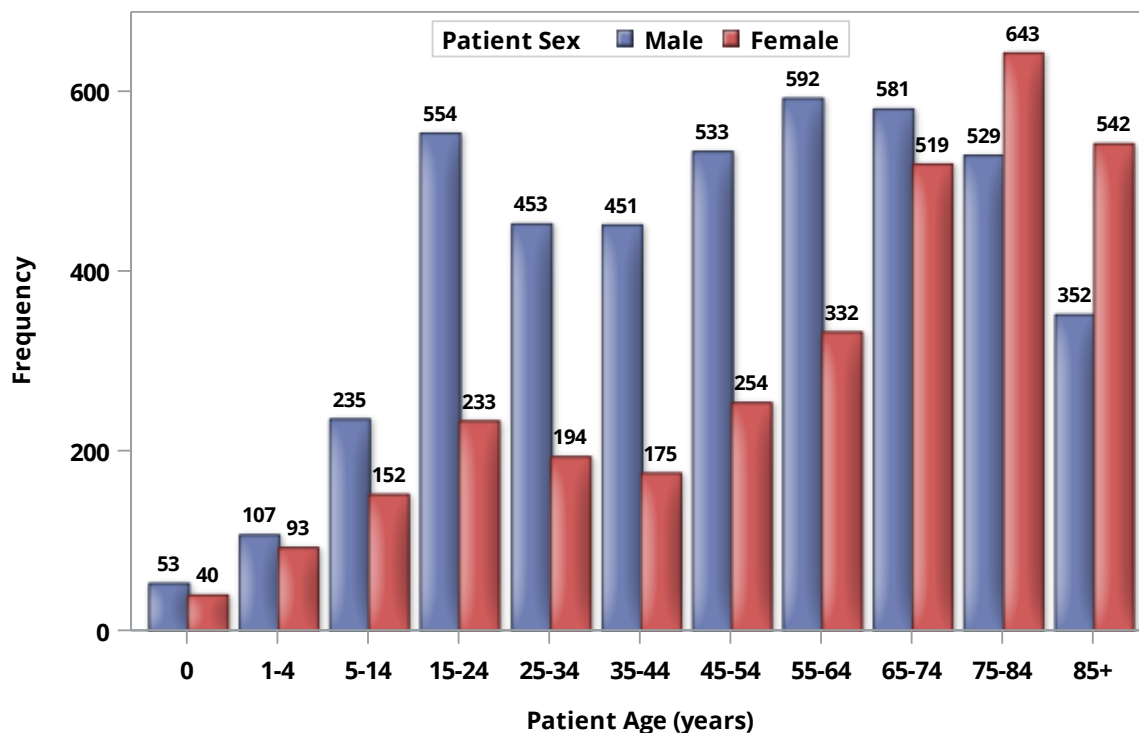
Patient Status	N	%
Alive at Discharge	6,778	89
Discharged with self-care or non-skilled assistance (routine discharges)	3,691	48
Discharged to a residential, rehabilitation, or other long term care facility (includes hospice home care)	2,862	38
Other Discharges (includes unknown and left without medical care)	225	3

Demographics

Although men were more likely to be discharged routinely (62%, N=2,278), they were also more likely to be discharged as deceased due to TBI-related causes (65%, N=372).

*Until recently, males sustained more TBIs in **every** age group.*

The majority of traumatic brain injury-related hospitalizations and deaths occur in the senior population; 54% (N=4,092) of patients with a reported TBI were over 55 years of age. More males (58%, N=4,440) sustained traumatic brain injuries than females, and this difference is seen within most age groups. However, within the age groups over 75 years, the trend changes and women sustain more TBIs than males (Figure 1). Females ages 75 to 84 comprised the largest proportion of TBI hospitalizations and deaths at just over 8% (N=643), followed by just under 8% (N=592) of men ages 55 to 64. Males ages 15 to 64 were over twice as likely to be hospitalized or expire due to a TBI-related cause as women of the same age groups.

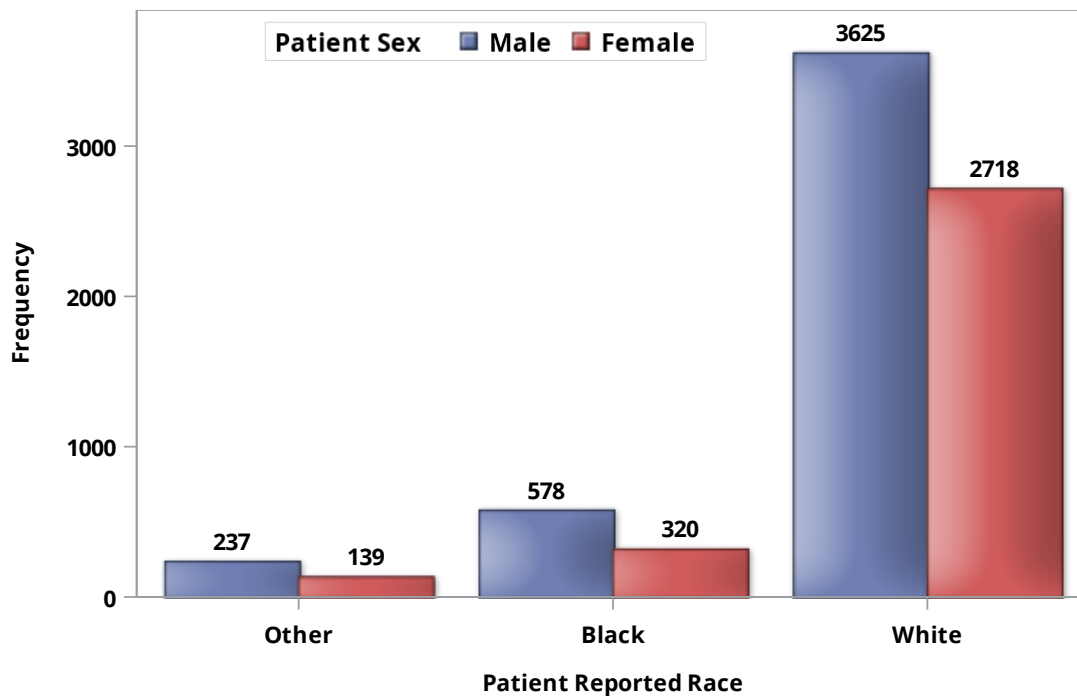


Traumatic Brain Injury Registry 2016 Final Data

Source: Tennessee Department of Health, Division of Family Health and Wellness, Traumatic Brain Injury Program

Figure 1. Number of TBI-Related Patients by Age Group and Sex, 2016.

Over 83% (N=6,346) of reported TBI patients were white, while only 12% (N=899) were black, and 5% (N=376) were all other races. Although white men are only slightly more likely to sustain a TBI, men of all other races were almost twice as likely (63%, N=815) to sustain a TBI as women of other races (Figure 2).



Traumatic Brain Injury Registry 2016 Final Data

Source: Tennessee Department of Health, Division of Family Health and Wellness, Traumatic Brain Injury Program

Figure 2. Traumatic brain injury hospitalizations and deaths by sex and race, 2016.

Head Injury Diagnoses

By far, the most common traumatic brain injuries reported were categorized as intracranial injuries. Although this may not be the primary TBI diagnosis in each case, over 90% (N=6,919) of patients were diagnosed with at least one of these traumatic brain injuries. In contrast, although they are the second most common TBI diagnosis, skull fractures were diagnosed in only 25% (N=1924) of hospitalizations and deaths.

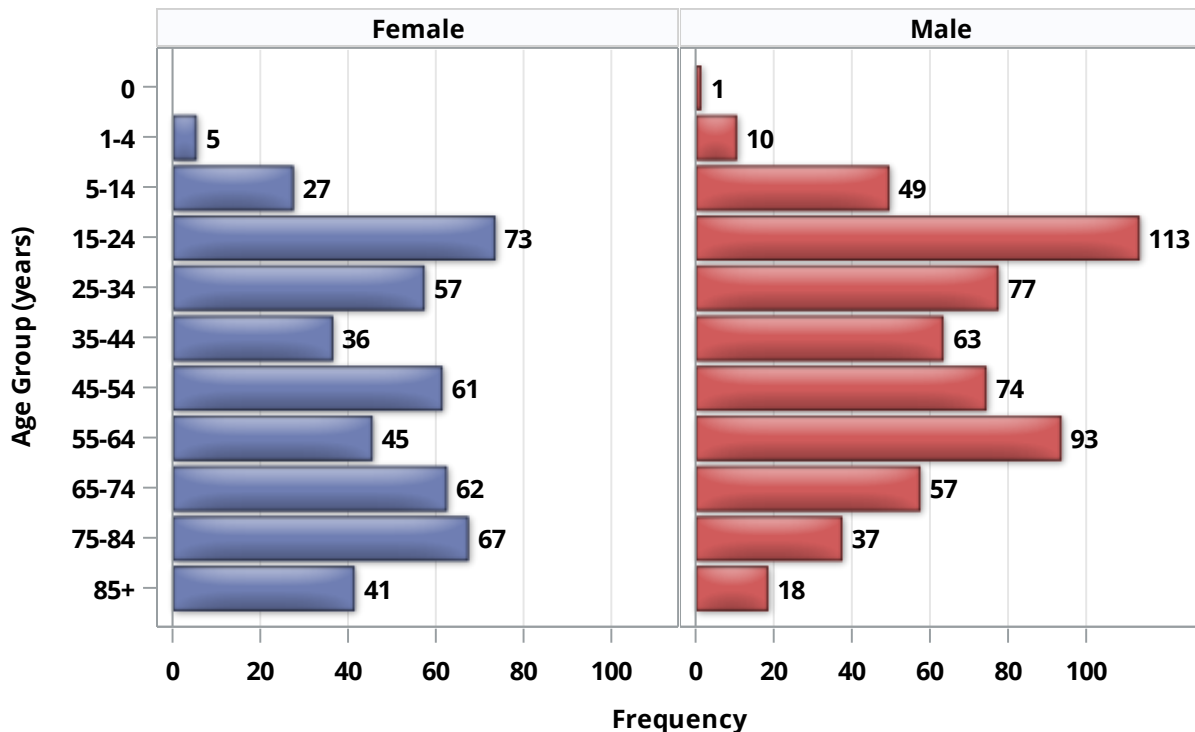
The causes of each of these injury diagnoses are quite different, due to the mechanisms at play. The most common cause of intracranial injuries is an accidental fall (42%, N=2,875), while the most common cause of a skull fracture is a transportation accident (37%, N=702) (Table 3).

Table 3. Head Injury Types as reported to the Traumatic Brain Injury Registry, 2016.

TBI Diagnosis	Total N(%)	Accidental Falls N(%)	Transport N(%)	Assault N(%)	Struck By/ Against N(%)	Suicide N(%)	All Other Causes N(%)
Skull Fractures (S02.0, S02.1-, S02.8, S02.91)	1924 (100)	530 (28)	702 (37)	124 (6)	60 (3)	61 (3)	445 (23)
Optic Injuries (S04.01-, S04.02-, S04.03-)	16 (100)	2 (13)	6 (38)	1 (6)	2 (13)	1 (6)	4 (25)
Intracranial Injuries (S06-)	6919 (100)	2875 (42)	2073 (30)	200 (3)	133 (2)	67 (1)	1546 (22)
Crushing Injuries (S07-)	10 (100)	2 (20)	8 (80)	0 (0)	0 (0)	0 (0)	0 (0)
Shaken Infant Syndrome (T74.4)	6 (100)	0 (0)	0 (0)	3 (50)	0 (0)	0 (0)	3 (50)

The least common diagnosis is shaken infant syndrome. This could be due either to a low incidence or the underreporting of child abuse within the state.

In ICD-10 coding, concussions are intracranial injuries with the first 4 digits of “S06.0.” Although concussions are the least severe intracranial injuries, they can still produce lasting effects in those who sustain them. In 2016, 14% (N=1,063) of TBI patients hospitalized or deceased were diagnosed with a concussion. Again, most concussion patients were males (55%, N=588) and 18% (N=188) of all concussion patients were between the ages of 15 and 24 (Figure 3).



Traumatic Brain Injury Registry 2016 Final Data

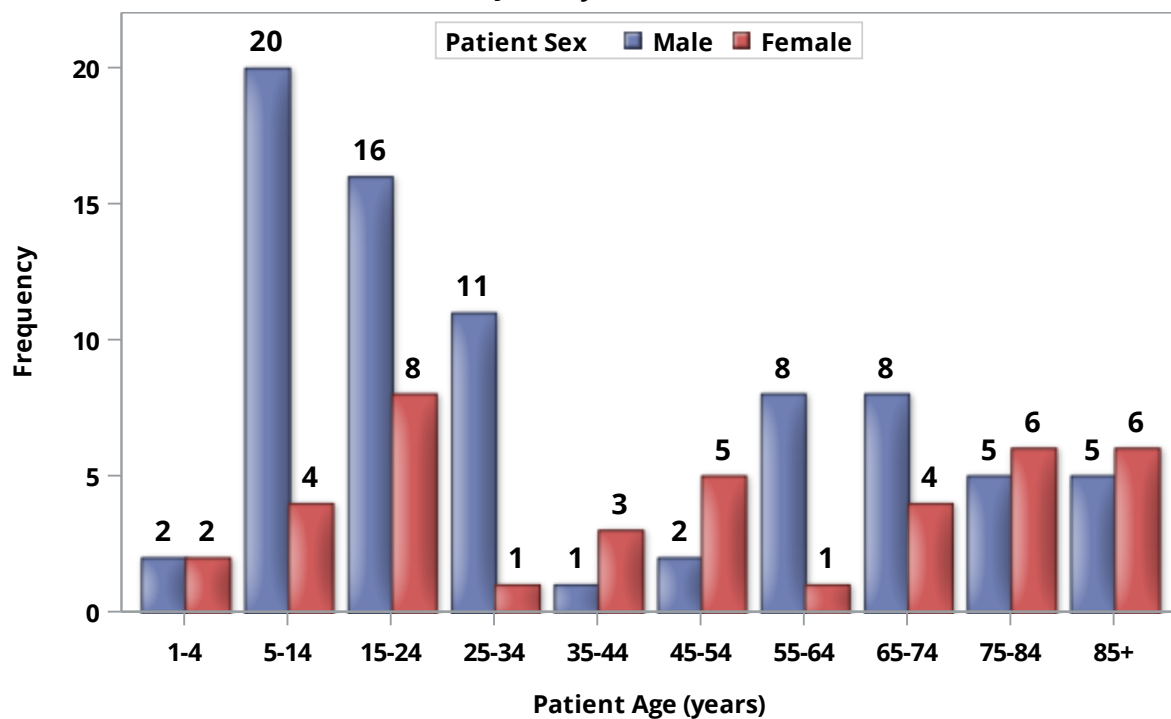
Source: Tennessee Department of Health, Division of Family Health and Wellness, Traumatic Brain Injury Program

Figure 3. TBI registry patients with concussion diagnoses by age and sex, 2016.

A recent study shows that almost 82% of pediatric concussion patients had their first visit within primary care and only 12% were seen in the emergency department³. Since this analysis is limited to inpatient hospitalizations and deaths and does not capture cases seen elsewhere (i.e. emergency department, primary care), it likely provides a substantial underestimation of the burden of concussion within the state.

³ Arbogast, KB et al. Point of Health Care Entry for Youth with Concussion within a Large Pediatric Care Network. *JAMA Pediatr.* 2016 Jul 5.

In 2013, the Tennessee General Assembly passed a sports concussion law aimed at increasing awareness of traumatic brain injuries and reducing youth sports concussions. Examining the incidence of sports concussion-related hospitalizations helps evaluate the impact of the law. In 2016, 11% (N=118) of the 1,063 patients that were hospitalized with a concussion were coded with a sports-related external cause. The majority of the patients hospitalized with sports-related concussions (41%, N=48) were youths between the ages of 5 and 24 (Figure 4).



Traumatic Brain Injury Registry 2016 Final Data

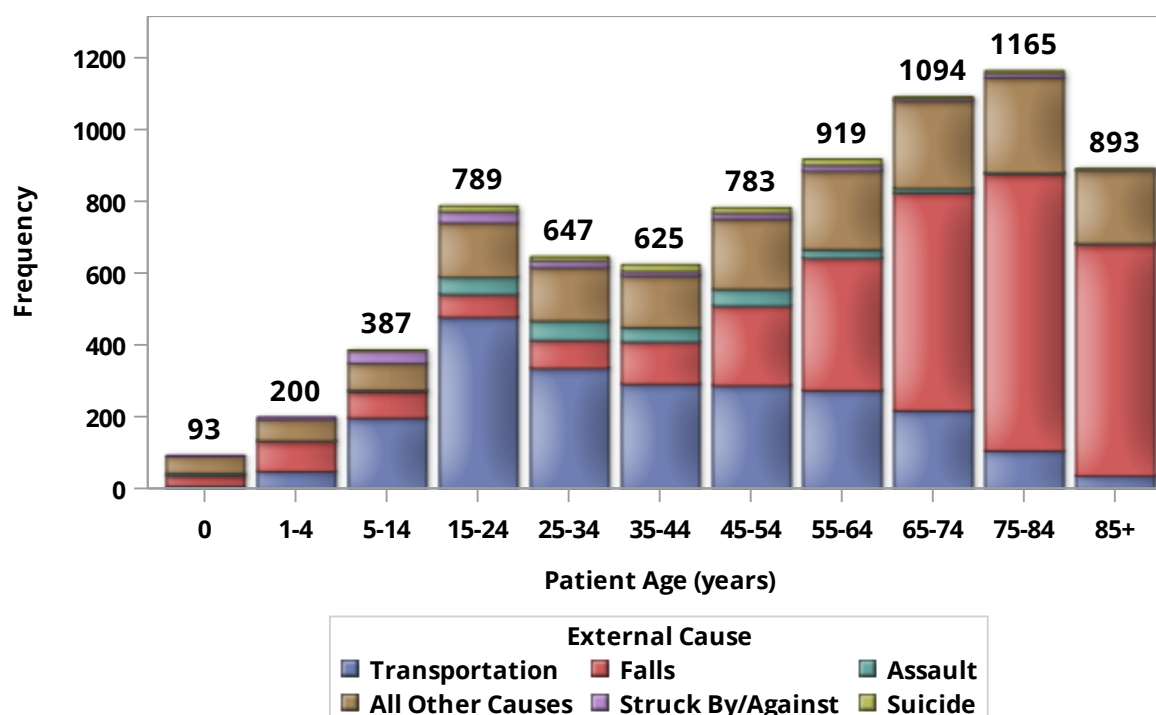
Source: Tennessee Department of Health, Division of Family Health and Wellness, Traumatic Brain Injury Program

Figure 4. Sports-related concussion hospitalizations by age and sex, 2016.

External Causes

External cause codes describe the mechanism by which the traumatic brain injury occurred. Although this is not a required field, as often the mechanisms are unknown or unclear, it is highly encouraged that this field is captured. For 2016, 82% of hospitalizations and deaths had at least one associated and appropriate external cause code.

Since the TBI Registry began collecting data in 1996, the two leading causes of traumatic brain injuries in Tennessee have been accidental falls and motor vehicle traffic accidents. Falls surpassed motor vehicle accidents as the most frequent cause of TBI in 2008, likely due to the increase of fall-related TBI in seniors⁴. In 2016, accidental falls remained the leading cause of TBI-related hospitalizations and deaths, accounting for 40% (N=3,055) of patients.



Traumatic Brain Injury Registry 2016 Provisional Data

Source: Tennessee Department of Health, Division of Family Health and Wellness, Traumatic Brain Injury Program

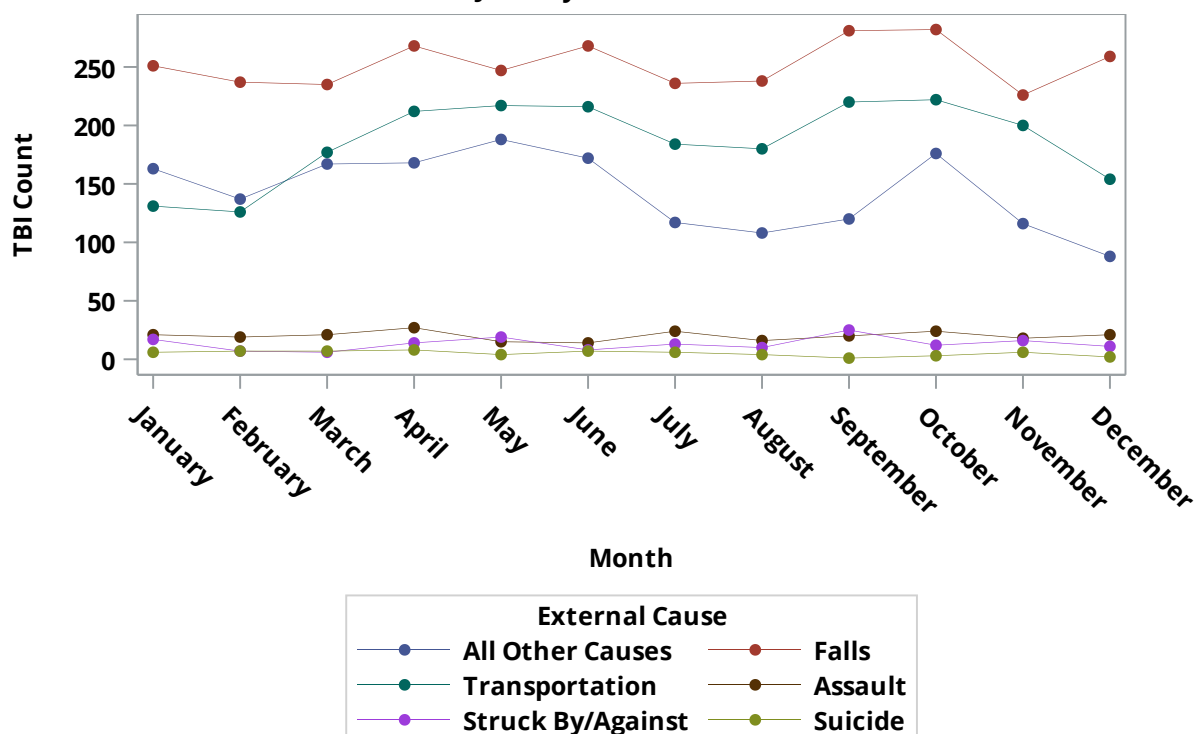
Figure 5. External causes of traumatic brain injury hospitalizations and deaths by age group, 2016.

⁴ Traumatic Brain Injury Registry, historical data, 1996 through 2015.

Falls were the leading cause of TBI-related hospitalization and death in children under 5 (39%, N=115) and adults over the age of 65 (64%, N=2,022). However, transportation accidents accounted for 30% (N=2,302) of TBI-related hospitalizations and deaths overall and were the leading cause of hospitalization and death in patients ages 5 to 64 (45%, N=1,878) (Figure 5).

Males were more likely to be hospitalized by a motor vehicle-related (64%, n=1,096) or assault-related TBI (79%, n=254) than women. Slightly more women (52%, n=1,801) sustained TBIs from falls than men, particularly in the age groups over 75.

Traumatic brain injury-related hospitalizations due to all causes seem to increase in the spring and fall. Motor vehicle traffic accident-related TBI hospitalizations increased slightly in April through June and again in September through November, while fall-related TBI hospitalizations peaked in September and October (Figure 6).

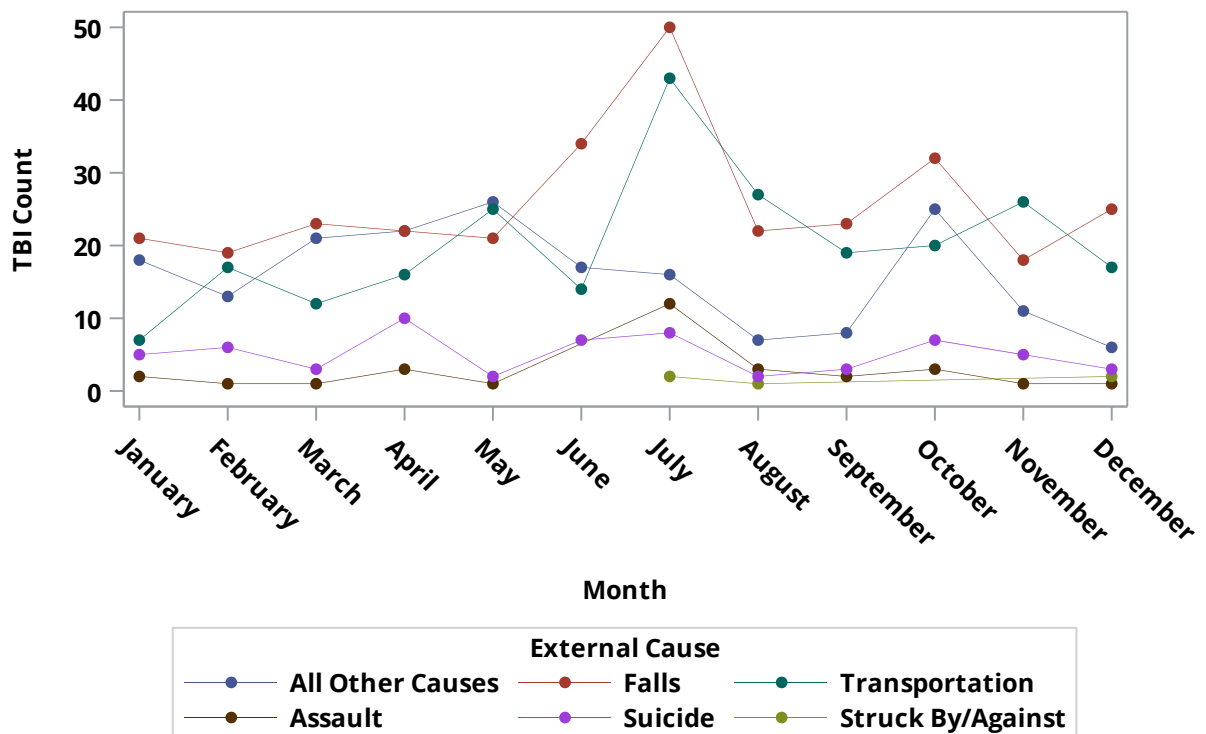


Traumatic Brain Injury Registry 2016 Final Data

Source: Tennessee Department of Health, Division of Family Health and Wellness, Traumatic Brain Injury Program

Figure 6. Traumatic brain injury causes of hospitalization and death by month of patient discharge, 2016.

In contrast, TBI-related deaths reported to the Registry peak in the summer, specifically in July (Figure 7). It is important to note that the deaths reported to the Registry are those that happen during hospitalization or before arrival at reporting hospitals. Therefore, they do not represent all TBI-related deaths in Tennessee, and temporal death patterns could be slightly different when including all TBI-related deaths.



Traumatic Brain Injury Registry 2016 Final Data

Source: Tennessee Department of Health, Division of Family Health and Wellness, Traumatic Brain Injury Program

Figure 7. Traumatic brain injury death causes by month of patient discharge or death, 2016.

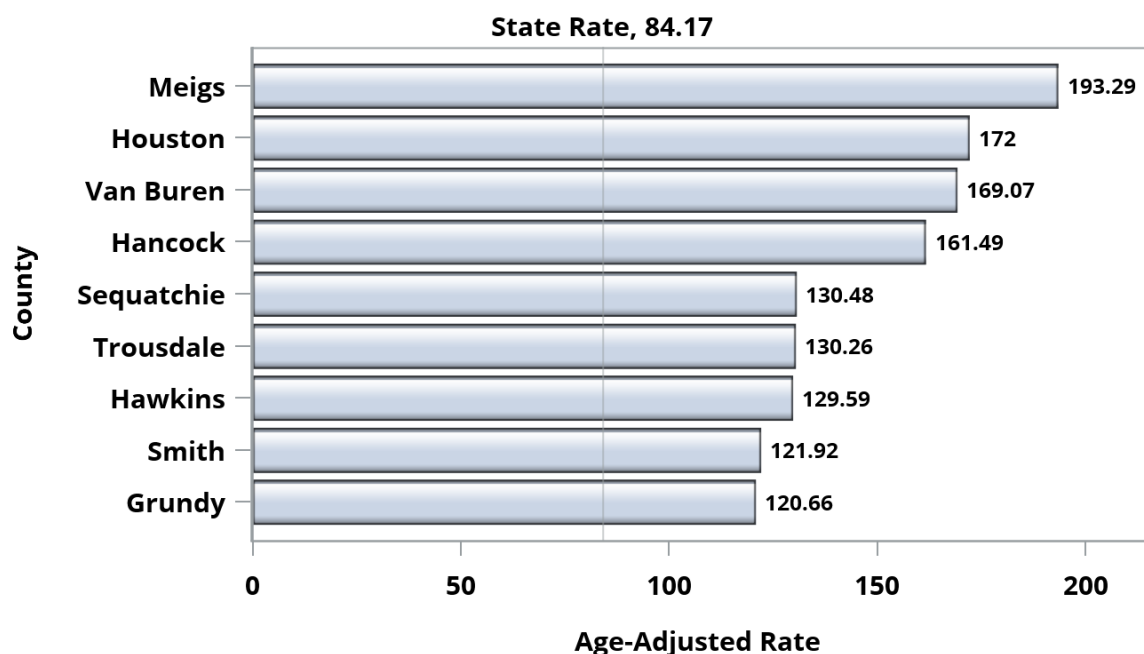
Rates

Unlike earlier calculations that included all TBI patients reported to and matching the legislative rules of the Registry, the following rates are calculated using only Tennessee resident patients.

Hospitalization Rates

Hospitalization rates are calculated using all patients that were reported as a hospitalization (length of stay ≥ 24 hours) to the Registry. 522 patients that died during their hospitalization are also counted in the death rate calculations.

In 2016, 5,586 Tennesseans were hospitalized with a TBI. The statewide age-adjusted rate of traumatic brain injury hospitalizations was 84.17 cases per 100,000 population (95% CI = 81.96, 86.38). The TBI-related hospitalization rates of the residents in Meigs, Houston, and Van Buren Counties were twice as high as the state rate (Figure 8). A full list of county-level hospitalization rates by county of patient residence can be found in Appendix A.



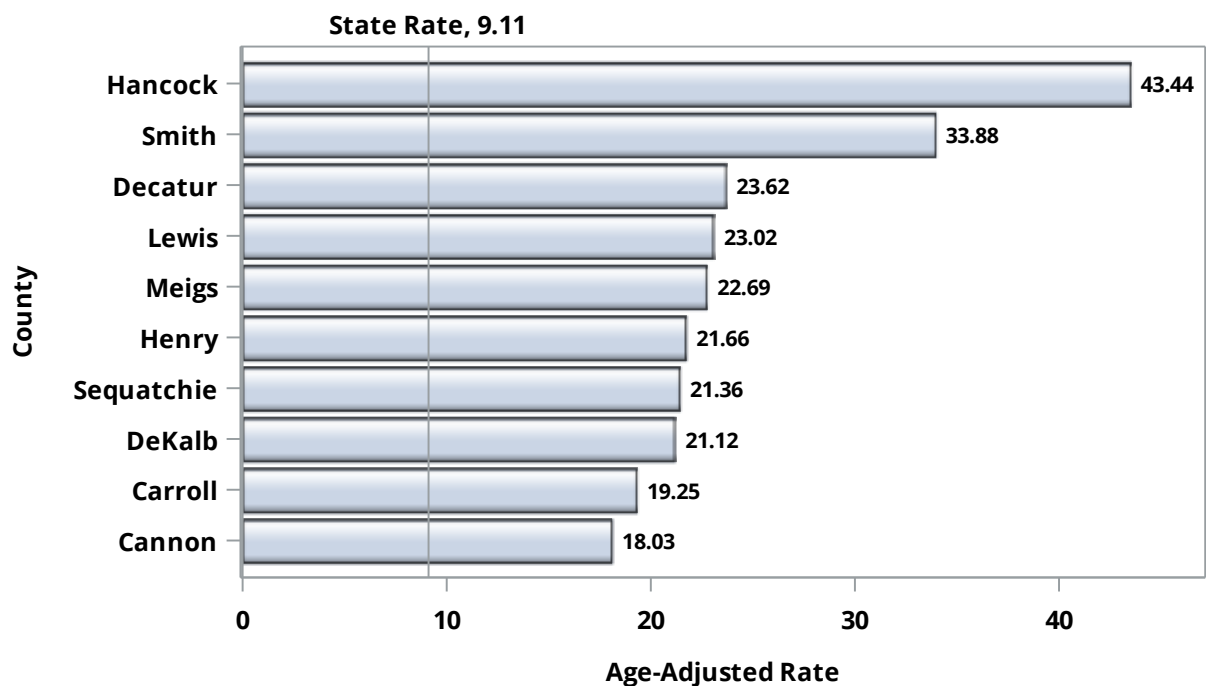
*Traumatic Brain Injury Registry 2016 Final Data
Rates based on 2016 County-Level Population Estimates provided by the Census Bureau
Source: Tennessee Department of Health, Division of Family Health and Wellness*

Figure 8. Top Ten County-Level Age-Adjusted TBI Hospitalization Rates per 100,000 Tennesseans, 2016.

Mortality Rates

Again, we must emphasize that the deaths captured by the Registry are those that happen during hospitalization or before arrival at reporting hospitals. Therefore, they do not represent all TBI-related deaths in Tennessee. For an idea of the full number of TBI-related deaths, we may look to the data collected using death certificates. In 2016, 1442 TBI-related deaths of Tennessee residents were captured using the death certificate data compared to 638 TBI-related deaths of Tennessee residents reported to the Registry⁵.

For the 638 Tennesseans who sustained a fatal TBI, the age-adjusted TBI mortality rate in 2016 was 9.11 TBI-related deaths per 100,000 population (95% CI = 8.41, 9.82). Nine counties had rates more than twice that of the state (Figure 9), although many counties had death counts under 20, which may cause the county-level age-adjusted rate to be statistically unstable. A full list of county level mortality rates can be found in Appendix B.



Traumatic Brain Injury Registry 2016 Final Data

Rates based on 2016 County-Level Population Estimates provided by the Census Bureau

Source: Tennessee Department of Health, Division of Family Health and Wellness

Figure 9. Top ten county-level age-adjusted TBI mortality rates per 100,000 Tennesseans, 2016.

⁵Data source: Tennessee Department of Health, Division of Policy, Planning and Assessment, Death Statistical System.

Additional Information

State of Patient Residence

Almost 75% (N=5,702) of reported TBI hospitalizations and fatal injuries involved a Tennessee resident, while just over 25% (N=1,919) involved non-residents, primarily from the states bordering Tennessee (Table 4).

Table 4. State of Residence of 7,621 TBI patients, 2016.

Patient State of Residence	N	%
Tennessee	5702	74.8
Alabama	123	1.6
Arkansas	180	2.4
Georgia	321	4.2
Kentucky	350	4.6
Mississippi	296	3.9
Missouri	24	0.3
North Carolina	62	0.8
Virginia	335	4.4
Other US States	228	3.0

State of Injury

The location of the incident resulting in the injury was unknown for almost one third (31%, N=2,333) of patients. Overall, more than half (57%, N=4,307) occurred in Tennessee, while another 12% (N=967) occurred in the states bordering Tennessee (Table 5).

Table 5. State of Injury of 7,621 TBI patients, 2016.

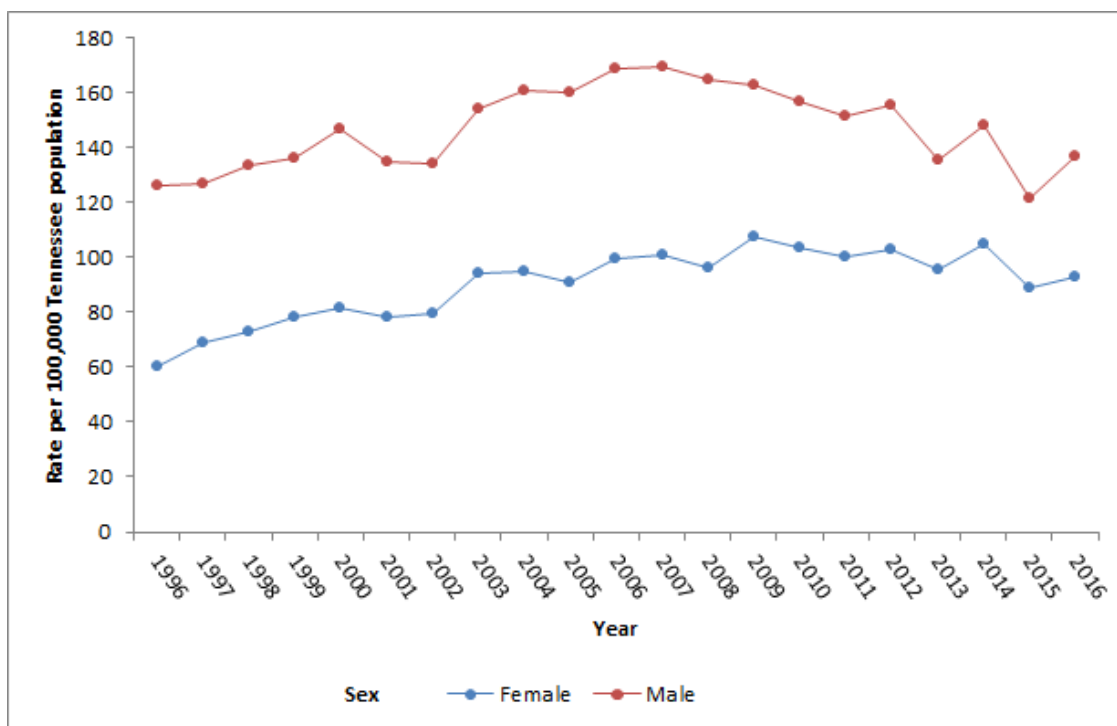
Patient State of Residence	N	%
Tennessee	4307	56.5
Alabama	71	0.9
Arkansas	62	0.8
Georgia	191	2.5
Kentucky	264	3.5
Mississippi	131	1.7
Missouri	6	0.1
North Carolina	33	0.4
Virginia	209	2.7
Other US States	14	0.2
Unknown	2333	30.6

Length of Stay

The average length of stay for a TBI-related hospitalization in 2016 was 6.4 days, remaining steady from 2015⁵.

Historical Trends

Males of all ages consistently sustain more traumatic brain injuries than females. Since the Registry's inception in 1996, the frequency of males hospitalized or deceased with any brain injury had been 56% higher than that of females on average (Figure 10). However, the difference has narrowed to only 34% in 2016.



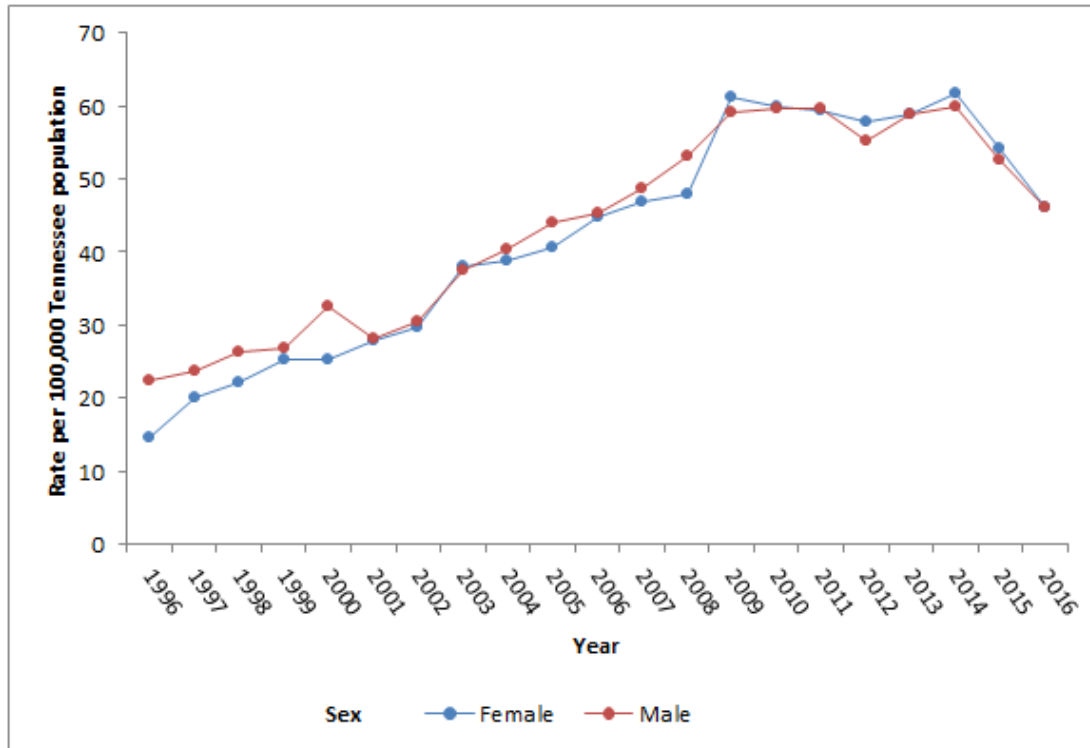
Traumatic Brain Injury Registry Provisional Data

Source: Tennessee Department of Health, Division of Family Health and Wellness. Population estimates from Tennessee Department of Health, Division of Policy, Planning and Assessment.

Figure 10. Rates of traumatic brain injury-related hospitalizations and deaths by sex, 1996-2016.

⁵ Traumatic Brain Injury Surveillance Annual Report, 2015. Tennessee Department of Health, Nashville, TN.

Figure 11 shows the pattern of fall-related TBI hospitalizations and deaths over time. Although falls seem to have declined since 2014, this is likely due to the change in coding from ICD-9 to ICD-10 during 2015.

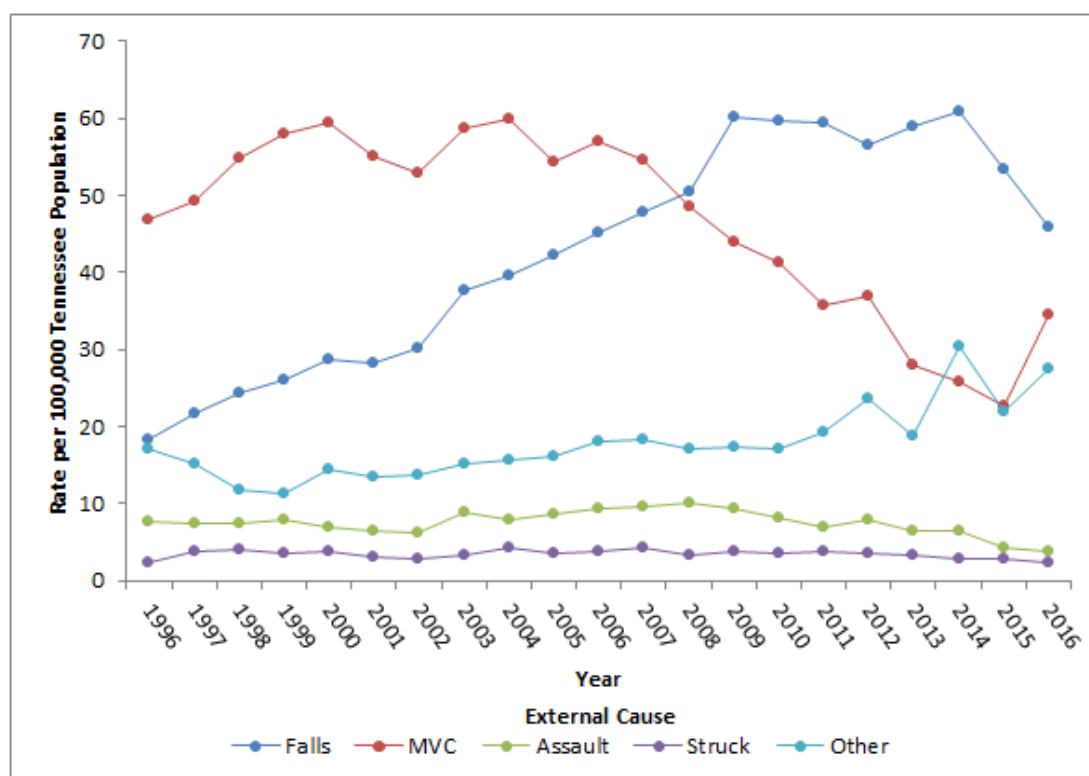


Traumatic Brain Injury Registry Provisional Data

Source: Tennessee Department of Health, Division of Family Health and Wellness. Population estimates from Tennessee Department of Health, Division of Policy, Planning and Assessment.

Figure 11. Rates of fall-related traumatic brain injury hospitalizations and deaths by sex, 1996-2016.

Figure 12 provides a snapshot of the patterns of all mechanisms of injury since 1996. Falls increased from 1996 to 2008, surpassing transport accidents that year to become the leading cause of TBI in Tennessee. The steady decline in transport accidents could be attributed to the enactment of the state's primary enforcement of seat belt use laws in 2004 and child passenger safety law in 2005.



Traumatic Brain Injury Registry Provisional Data

Source: Tennessee Department of Health, Division of Family Health and Wellness. Population estimates from Tennessee Department of Health, Division of Policy, Planning and Assessment.

Figure 12. Rates of TBI-related hospitalizations and deaths by cause, 1996-2016.

Limitations

Although measures were taken to reduce the effect of coding errors, TBI cases may still be misclassified. For instance, the TDH Child Fatality Review program identified two deaths due to pediatric abusive head trauma in 2016 that were not coded as such in the TBI database.

There are multiple methodologies available to analyze registry data. The program chose to evaluate demographics for all TBI cases (both hospitalizations and deaths) for conciseness, while separating deaths and hospitalizations for rate calculations. Additional demographic analyses are available upon request.

Some hospitals submit data on TBI-related emergency department visits and inpatient observations lasting less than 24 hours. However, these are not required to be reported to the registry. It is unknown if patients treated in these situations, who sustain assumingly

less severe brain injuries, may also require the services provided through the TBI program due to lasting effects.

Conclusion

TBI still contributes to a significant proportion of death and disability in the State of Tennessee; the number of patients reported to the registry has steadily increased since 1996. Fortunately, T.C.A. 68-55-203 has enabled the TBI Program to provide assistance to over 80,000 Tennessean survivors since this legislation came into effect. Continuous surveillance of TBI allows us for targeted interventions that may alleviate this burden.

Recent advancements in neurological science and clinical care allow for improved intervention and long-term outcomes in TBI patients. However, these injuries still occur at alarming rates and often, patients are still in need of long-term assistance. The findings in this report not only emphasize the continued need for these TBI patient resources in Tennessee, but also highlight the opportunity to enhance TBI prevention efforts across the state.

Acknowledgements

The Tennessee Department of Health would like to acknowledge all the reporting hospitals across Tennessee, especially the staff involved in reporting to the Registry.

Contacts

Additional TBI reports and fact sheets may be found at <https://www.tn.gov/health/health-program-areas/fhw/vipp/tbi.html> For additional information on the Traumatic Brain Injury Program, please call 1.800.882.0611.

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Appendix A

County-level age-adjusted hospitalization rates for 5,586 Tennesseans hospitalized during the calendar year of 2016.

County	TBI-Related Hospitalization Count	2016 County Population	Age-Adjusted Hospitalization Rate	95% Confidence Intervals	Relative Rate*
Anderson	76	77995	81.51	63.19, 99.84	0.97
Bedford	39	53091	70.51	48.38, 92.64	0.84
Benton	17	16385	76.93	40.36, 113.5	0.91
Bledsoe	9	14987	59.57	20.65, 98.48	0.71
Blount	99	132789	60.11	48.27, 71.95	0.71
Bradley	104	110842	90.28	72.93, 107.64	1.07
Campbell	32	40205	68.05	44.47, 91.63	0.81
Cannon	19	14365	101.99	56.13, 147.85	1.21
Carroll	42	28816	108.56	75.73, 141.4	1.29
Carter	29	57517	46.27	29.43, 63.11	0.55
Cheatham	33	41007	85	56, 114	1.01
Chester	17	17861	79.88	41.91, 117.85	0.95
Claiborne	23	32175	74.7	44.17, 105.23	0.89
Clay	5	7926	42.25	5.22, 79.29	0.5
Cocke	39	36000	91.37	62.69, 120.04	1.09
Coffee	50	56959	78.05	56.41, 99.68	0.93
Crockett	16	15900	86.69	44.21, 129.17	1.03
Cumberland	73	60323	84.3	64.96, 103.64	1
Davidson	643	753451	92.6	85.45, 99.76	1.1
DeKalb	13	20790	107.23	48.94, 165.52	1.27
Decatur	24	12167	90.63	54.37, 126.89	1.08
Dickson	45	53925	79.21	56.07, 102.35	0.94
Dyer	30	39010	70.8	45.46, 96.14	0.84
Fayette	15	40577	32.7	16.15, 49.25	0.39
Fentress	17	18268	83.29	43.7, 122.89	0.99
Franklin	40	43001	86.11	59.43, 112.8	1.02
Gibson	36	50735	58.96	39.7, 78.22	0.7
Giles	13	29990	35.24	16.08, 54.39	0.42
Grainger	22	23847	91.39	53.2, 129.57	1.09
Greene	53	70504	66.33	48.47, 84.19	0.79
Grundy	18	13519	120.66	64.92, 176.4	1.43

County	TBI-Related Hospitalization Count	2016 County Population	Age-Adjusted Hospitalization Rate	95% Confidence Intervals	Relative Rate*
Hamblen	57	71151	75.23	55.7, 94.76	0.89
Hamilton	349	377138	87.63	78.44, 96.83	1.04
Hancock	13	6583	161.49	73.7, 249.28	1.92
Hardeman	27	25872	93.94	58.51, 129.38	1.12
Hardin	18	26234	65.15	35.05, 95.24	0.77
Hawkins	79	57371	129.59	101.01, 158.17	1.54
Haywood	17	18636	74.68	39.18, 110.18	0.89
Henderson	18	28426	57.63	31.01, 84.25	0.68
Henry	33	33071	92.37	60.86, 123.89	1.1
Hickman	29	24872	114.59	72.88, 156.29	1.36
Houston	18	8292	172	92.54, 251.46	2.04
Humphreys	24	18786	109.34	65.6, 153.09	1.3
Jackson	7	11764	48.85	12.66, 85.04	0.58
Jefferson	40	55374	63.72	43.97, 83.46	0.76
Johnson	12	18096	59.14	25.68, 92.61	0.7
Knox	338	474549	67.42	60.23, 74.6	0.8
Lake	3	7735	37.27	-4.91, 79.45	0.44
Lauderdale	22	27451	81.93	47.69, 116.16	0.97
Lawrence	40	44010	85.98	59.33, 112.63	1.02
Lewis	14	12183	114.77	54.65, 174.89	1.36
Lincoln	16	34757	36.98	18.86, 55.1	0.44
Loudon	55	55745	77.54	57.05, 98.04	0.92
Macon	26	24650	101.67	62.59, 140.76	1.21
Madison	77	101326	70.81	55, 86.63	0.84
Marion	18	28946	58.07	31.24, 84.9	0.69
Marshall	23	33521	66.36	39.24, 93.48	0.79
Maur	63	95071	65.45	49.29, 81.62	0.78
McMinn	49	54938	82	59.04, 104.96	0.97
McNairy	27	26478	87.7	54.62, 120.78	1.04
Meigs	25	12246	193.29	117.52, 269.06	2.3
Monroe	43	47917	83.92	58.83, 109	1
Montgomery	111	215245	61.71	50.23, 73.19	0.73
Moore	1	6429	8.53	-8.19, 25.25	0.1
Morgan	19	21812	88.28	48.58, 127.97	1.05
Obion	17	31847	46.92	24.61, 69.22	0.56
Overton	16	22351	67.67	34.51, 100.83	0.8
Perry	7	8155	64.95	16.83, 113.07	0.77
Pickett	5	5221	107.97	13.33, 202.61	1.28
Polk	19	17116	96.65	53.19, 140.12	1.15

County	TBI-Related Hospitalization Count	2016 County Population	Age-Adjusted Hospitalization Rate	95% Confidence Intervals	Relative Rate*
Putnam	62	80628	72.19	54.22, 90.15	0.86
Rhea	37	33999	94.24	63.88, 124.61	1.12
Roane	58	53803	85.39	63.41, 107.36	1.01
Robertson	67	73664	91.9	69.9, 113.91	1.09
Rutherford	213	331604	74.24	64.27, 84.21	0.88
Scott	13	22120	52.88	24.13, 81.63	0.63
Sequatchie	23	15391	130.48	77.15, 183.8	1.55
Sevier	85	102077	77.66	61.15, 94.18	0.92
Shelby	617	992013	63.75	58.72, 68.78	0.76
Smith	23	19906	121.92	72.09, 171.74	1.45
Stewart	9	13546	50.81	17.62, 84.01	0.6
Sullivan	198	159453	110.19	94.84, 125.54	1.31
Sumner	219	188444	114.83	99.62, 130.04	1.36
Tipton	39	62929	61.42	42.14, 80.69	0.73
Trousdale	11	8517	130.26	53.28, 207.24	1.55
Unicoi	11	18553	58.16	23.79, 92.54	0.69
Union	16	19434	76.69	39.11, 114.27	0.91
Van Buren	10	5732	169.07	64.28, 273.87	2.01
Warren	32	44044	69	45.09, 92.9	0.82
Washington	84	131698	56.97	44.78, 69.15	0.68
Wayne	7	17059	33.2	8.6, 57.79	0.39
Weakley	15	34257	40.69	20.1, 61.28	0.48
White	36	27348	119.2	80.26, 158.13	1.42
Williamson	116	229294	53.05	43.4, 62.71	0.63
Wilson	119	138081	84.17	69.04, 99.29	1
Tennessee	5586	6999886	84.17	81.96, 86.38	1

*-Relative rate as compared to the state age-adjusted rate.

Appendix B

County-level age-adjusted mortality rates for 638 Tennesseans with fatal traumatic brain injury during the calendar year of 2016. Please interpret with caution.

County	TBI-Related Fatality Count	2016 County Population	Age-Adjusted Mortality Rate	95% Confidence Intervals	Relative Rate
Anderson	5	77995	4.99	0.62, 0.55	0.55
Bedford	5	53091	10.25	1.27, 1.13	1.13
Benton	2	16385	7	-2.7, 0.77	0.77
Bledsoe	2	14987	11.46	-4.42, 1.26	1.26
Blount	11	132789	7.15	2.92, 0.78	0.78
Bradley	4	110842	2.88	0.06, 0.32	0.32
Campbell	4	40205	8.44	0.17, 0.93	0.93
Cannon	3	14365	18.03	-2.37, 1.98	1.98
Carroll	7	28816	19.25	4.99, 2.11	2.11
Carter	3	57517	4.6	-0.61, 0.5	0.5
Cheatham	6	41007	15.15	3.03, 1.66	1.66
Chester	1	17861	3.78	-3.62, 0.41	0.41
Claiborne	2	32175	7.43	-2.87, 0.82	0.82
Clay	0	7926	0	0, 0	0
Cocke	1	36000	2.61	-2.51, 0.29	0.29
Coffee	7	56959	10.06	2.61, 1.1	1.1
Crockett	1	15900	5.71	-5.48, 0.63	0.63
Cumberland	11	60323	14.49	5.93, 1.59	1.59
Davidson	77	753451	11.06	8.59, 1.21	1.21
DeKalb	5	20790	21.12	2.61, 2.32	2.32
Decatur	3	12167	23.62	-3.11, 2.59	2.59
Dickson	10	53925	16.83	6.4, 1.85	1.85
Dyer	2	39010	5.14	-1.98, 0.56	0.56
Fayette	2	40577	4.29	-1.66, 0.47	0.47
Fentress	2	18268	6.88	-2.66, 0.76	0.76
Franklin	6	43001	13.05	2.61, 1.43	1.43
Gibson	6	50735	9.69	1.94, 1.06	1.06
Giles	2	29990	8.22	-3.17, 0.9	0.9
Grainger	2	23847	8.96	-3.46, 0.98	0.98
Greene	9	70504	9.74	3.38, 1.07	1.07
Grundy	0	13519	0	0, 0	0
Hamblen	4	71151	6.16	0.12, 0.68	0.68

County	TBI-Related Fatality Count	2016 County Population	Age-Adjusted Mortality Rate	95% Confidence Intervals	Relative Rate
Hamilton	29	377138	7.22	4.59, 0.79	0.79
Hancock	4	6583	43.44	0.87, 4.77	4.77
Hardeman	3	25872	10.77	-1.42, 1.18	1.18
Hardin	3	26234	9.32	-1.23, 1.02	1.02
Hawkins	9	57371	14.68	5.09, 1.61	1.61
Haywood	2	18636	8.21	-3.17, 0.9	0.9
Henderson	6	28426	17.87	3.57, 1.96	1.96
Henry	7	33071	21.66	5.61, 2.38	2.38
Hickman	2	24872	8.05	-3.11, 0.88	0.88
Houston	2	8292	15.57	-6.01, 1.71	1.71
Humphreys	3	18786	11.61	-1.53, 1.27	1.27
Jackson	1	11764	4.28	-4.11, 0.47	0.47
Jefferson	2	55374	2.86	-1.1, 0.31	0.31
Johnson	1	18096	4.06	-3.9, 0.45	0.45
Knox	37	474549	7.06	4.78, 0.77	0.77
Lake	0	7735	0	0, 0	0
Lauderdale	2	27451	6.71	-2.59, 0.74	0.74
Lawrence	7	44010	14.54	3.77, 1.6	1.6
Lewis	3	12183	23.02	-3.03, 2.53	2.53
Lincoln	1	34757	2.81	-2.7, 0.31	0.31
Loudon	1	55745	1.09	-1.05, 0.12	0.12
Macon	5	24650	17.2	2.12, 1.89	1.89
Madison	12	101326	10.67	4.63, 1.17	1.17
Marion	1	28946	1.96	-1.88, 0.22	0.22
Marshall	4	33521	9.23	0.18, 1.01	1.01
Maury	8	95071	9.34	2.87, 1.03	1.03
McMinn	5	54938	7.87	0.97, 0.86	0.86
McNairy	4	26478	13.18	0.26, 1.45	1.45
Meigs	3	12246	22.69	-2.99, 2.49	2.49
Monroe	4	47917	7.66	0.15, 0.84	0.84
Montgomery	20	215245	9.47	5.32, 1.04	1.04
Moore	0	6429	0	0, 0	0
Morgan	1	21812	5.61	-5.38, 0.62	0.62
Obion	2	31847	6.47	-2.5, 0.71	0.71
Overton	2	22351	8.13	-3.14, 0.89	0.89
Perry	1	8155	9.17	-8.8, 1.01	1.01
Pickett	0	5221	0	0, 0	0
Polk	1	17116	4.4	-4.22, 0.48	0.48
Putnam	10	80628	11.36	4.32, 1.25	1.25

County	TBI-Related Fatality Count	2016 County Population	Age-Adjusted Mortality Rate	95% Confidence Intervals	Relative Rate
Rhea	1	33999	2	-1.92, 0.22	0.22
Roane	6	53803	9.28	1.85, 1.02	1.02
Robertson	9	73664	12.59	4.36, 1.38	1.38
Rutherford	18	331604	6.15	3.31, 0.68	0.68
Scott	2	22120	6.08	-2.35, 0.67	0.67
Sequatchie	3	15391	21.36	-2.81, 2.34	2.34
Sevier	9	102077	6.62	2.3, 0.73	0.73
Shelby	63	992013	6.5	4.9, 0.71	0.71
Smith	6	19906	33.88	6.77, 3.72	3.72
Stewart	1	13546	5.79	-5.56, 0.64	0.64
Sullivan	19	159453	11.33	6.24, 1.24	1.24
Sumner	17	188444	8.59	4.51, 0.94	0.94
Tipton	2	62929	2.48	-0.96, 0.27	0.27
Trousdale	0	8517	0	0, 0	0
Unicoi	1	18553	6.71	-6.45, 0.74	0.74
Union	1	19434	4.86	-4.67, 0.53	0.53
Van Buren	0	5732	0	0, 0	0
Warren	9	44044	17.42	6.04, 1.91	1.91
Washington	14	131698	8.97	4.27, 0.98	0.98
Wayne	2	17059	10.62	-4.1, 1.17	1.17
Weakley	2	34257	6.34	-2.45, 0.7	0.7
White	3	27348	7.45	-0.98, 0.82	0.82
Williamson	21	229294	10.28	5.88, 1.13	1.13
Wilson	16	138081	11.8	6.02, 1.3	1.3
Tennessee	638	6999886	9.11	8.41, 1	1

*-Relative rate as compared to the state age-adjusted rate.